Measuring Neutrino Oscillation Parameters With Atmospheric Neutrinos *This Decade*

❖ Atmospheric neutrino experiments have played a central part in the discovery of neutrino oscillations.

❖ **Current and next-generation atmospheric neutrino experiments (IceCube, IceCube-Upgrade, Super-K, Super-K-Gd, and KM3nET-ORCA) have comparable or better sensitivity to neutrino oscillation parameters.**

❖ Beyond determining the oscillation parameters, atmospheric neutrino experiments also **play a significant role in constraining physics Beyond the Standard Model**, e.g., non-standard neutrino interactions, among others.
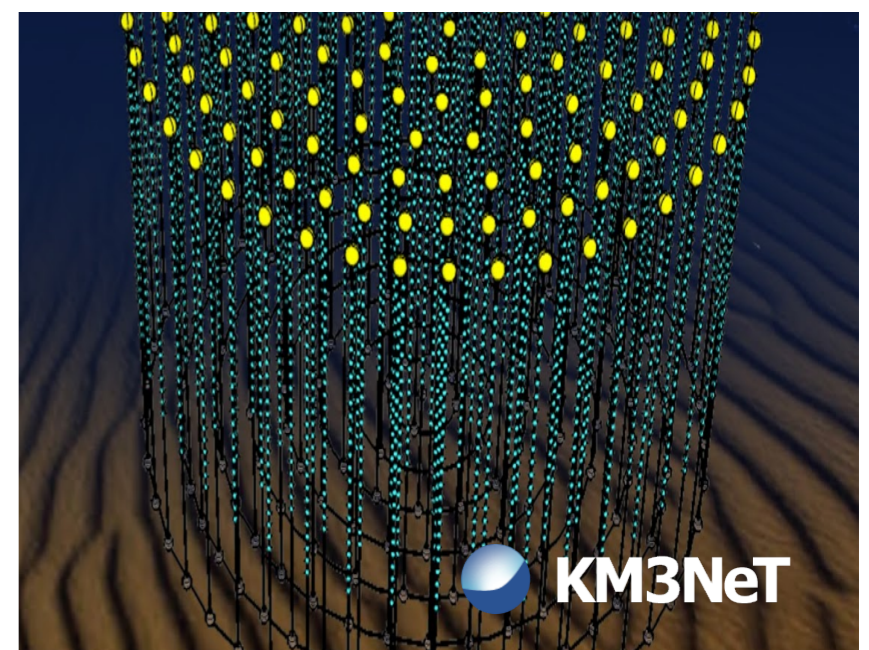
Super-K
Already operating in Gd mode

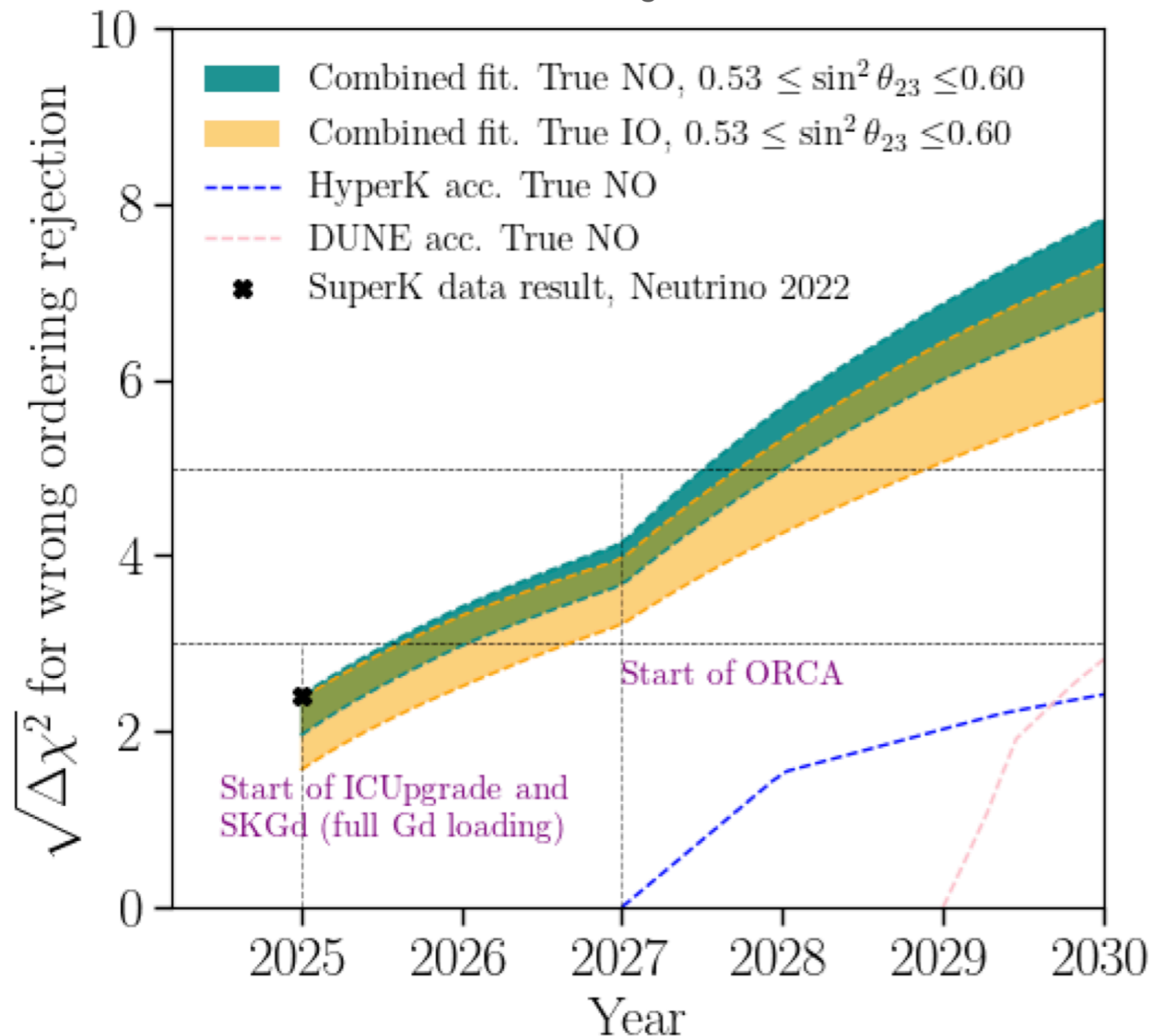**IceCube and IceCube-Upgrade**
Funded to be deployed in 2025
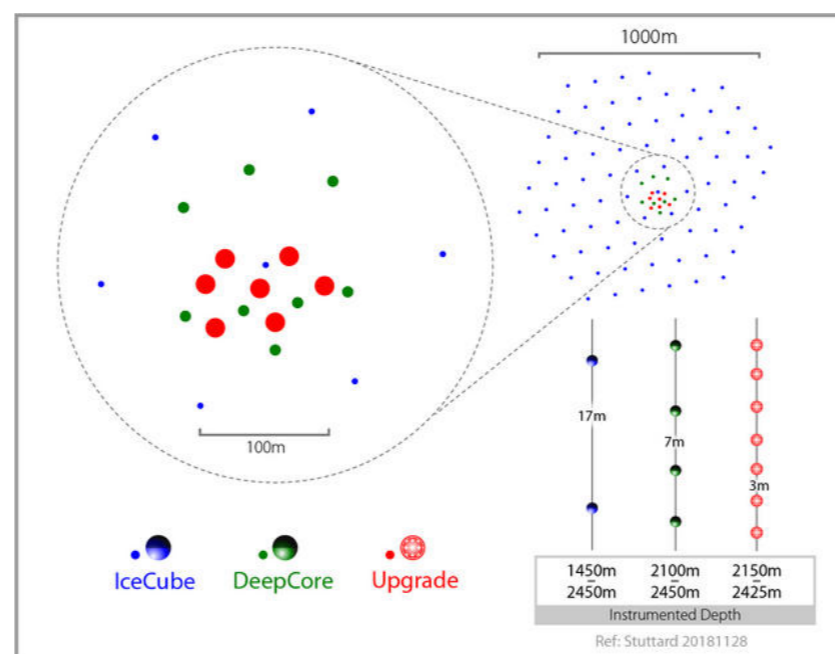
KM3NeT/ORCA
Under construction, more than 15% built (7,500 PMTs)

Carlos A. Argüelles — Harvard University

1

Neutrino Ordering Determination With Atmospherics by 2030 (At the Start of DUNE)

C. A. Argüelles et al. arXiv:2211.02666

Combination of atmospheric experiments will determine the neutrino ordering unambiguously by the end of the decade.

This is without JUNO!

Take Home Message

Atmospheric neutrino experiments that will operate this decade will significantly change the landscape of neutrino oscillation measurements by 2030.

Combination of the experiments capabilities, in particular, SK-Gd, enables access to the CP-phase on an orthogonal data set than long-baseline experiments.

By 2030: Two measurements of CP-phase
- Accelerator: T2K+Nova
- Atmospheric: IceCube + SK + ORCA

Capacities of atmospheric neutrino experiments need to be taken into account when planning next-generation experiments (DUNE, HK, IceCube-Gen2).

C. A. Argüelles et al. arXiv:2211.02666

Legend:
- Current reactor data fit
- HyperK LBL projection for 2030 (3 years)
- Current NOvA data fit
- Current T2K data fit
- Combined atm.ν projection (this work)

Parameters shown: $\sin^2 \theta_{23}$, Δm^2_{31}, δ_{CP}, $\sin^2 \theta_{13}$

Axis: -90% -20% -5% -1% μ 1% 5% 20% 90%